Nonfatal Hospitalized Traumatic Brain Injury

Minnesota 1998-2003

Extent of the problem

Analysis of falls and motor vehicle crashes

Role of alcohol and protective equipment

MINNESOTA MDH DEPARTMENT OF HEALTH

Injury and Violence PREVENTION

May 2005

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Injury and Violence
PREVENTION

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Nonfatal Hospitalized Traumatic Brain Injury in Minnesota, 1998-2003

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Nonfatal Hospitalized Traumatic Brain Injury In Minnesota, 1998-2003

Abstract

Background: Each year in Minnesota, approximately 4,000 individuals are hospitalized as a result of a nonfatal traumatic brain injury (TBI). The Centers for Disease Control and Prevention (CDC) has published previous Minnesota data.[1,2]

Methods: This report summarizes surveillance data from the Minnesota Department of Health (MDH), Injury and Violence Prevention Unit, for nonfatal hospitalized TBI in Minnesota for 1998-2003. The data follow the case definition developed by the CDC.

All 132 operating and licensed Minnesota hospitals submit discharge data on central nervous system injuries to the MDH. The MDH also identified TBI cases from hospital discharge data and from other statewide injury data systems. Supplementary information was abstracted from a random sample of medical records.

Results: During 1998-2003, there were 25,328 cases of nonfatal hospitalized TBI in Minnesota, yielding an annualized adjusted rate of 85.1 per 100,000 population. The data show an increasing trend during those six years. Comparison with the previous five years (1993-1997) is difficult because of changes in case identification methods. The rate of TBI was higher in the seven-county metropolitan area than in Greater Minnesota (the rest of the state).

The impact of falls and motor vehicle crashes on TBI rates is particularly strong, and these causes are analyzed separately. Minnesota has higher fall rates compared to other states. Blood alcohol concentration (BAC) and use or non-use of personal protective equipment are described for motor vehicle crashes in which occupants, motorcyclists, and pedal cyclists are injured. In addition, alcohol use is analyzed in relation to pedestrian injuries, falls, assaults, and unintentional struck by/against injuries.

Males are at particularly high risk for TBI with a rate almost twice as high as the female rate. For both genders, there is a tri-modal pattern showing peaks in TBI rates for infants, for youth and young adults, and for those over age 65. Racial differences were evident; Blacks and American Indians were over-represented and Asians were under-represented.

Discussion: Data in this report show the importance of TBI as a public health problem. Population-based information regarding TBI hospitalizations can be useful in assessing the effect of prevention efforts, planning for the service needs of persons with TBI and suggesting ideas for future work such as outcome studies.

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1 MMWR, 14 State Report, *Traumatic Brain Injury-Related Hospital Discharges*, *1997*, 2003.

2 Thurman DJ, Alverson C, Dunn KA, Guerrero J, Sniezek JE. Traumatic brain injury in the United States: A public health perspective. J Head Trauma Rehabil 1999; 14(6):602-615.

Background

Scope of problem: Between 1980 and 1995, there was a national decrease of overall rates of hospitalization for TBI.[3,4] The rates declined an estimated 51 percent, from 199 to 98 per 100,000.[3] An estimated 80,000-90,000 Americans experience permanent disability from TBI.

In 1991, the Minnesota Legislature passed Minnesota Statutes 144.661-144.665, mandating the creation of a TBI and Spinal Cord Injury (TBI/SCI) Registry. The MDH has collected TBI data for injuries sustained from January 1993 to present. The TBI surveillance activity has its foundation in the state-mandated TBI/SCI Registry, and is supplemented with CDC funding.

Minnesota was one of 14 states to provide 1997 TBI surveillance data for a CDC *Morbidity and Mortality Weekly Report* (MMWR) article titled "Traumatic Brain Injury-Related Hospital Discharges." This report intends to provide updated information about nonfatal hospitalized TBI in Minnesota, from 1998-2003, with special emphasis on examining trends by age, gender, cause, race and geographic distribution.

Methods

Data represent TBI-related discharges from acute care hospitals over a six-year period, January 1, 1998 to December 31, 2003, among Minnesota residents. TBI-related deaths were excluded. The report includes TBI data from the Minnesota Hospital Association and the Minnesota TBI/SCI Registry. Abstracted hospital data from 1998-1999 are included where noted.

Case Identification

In 1991, the Minnesota Legislature authorized the development of a statewide Traumatic Brain Injury and Spinal Cord Injury (TBI/SCI) Registry. Statewide data collection began in January 1993, with each of Minnesota's 132 licensed and operating acute care hospitals required to report their in-patient TBI discharge data.

Cases were identified via Minnesota Hospital Association (MHA) universal billing (UB 92) data and the statewide TBI/SCI Registry.

Case Definition

Conceptual Definition: Traumatic Brain Injury (TBI) is an occurrence of injury to the head resulting from blunt trauma or acceleration or deceleration forces with one or more of the following conditions attributable to the head injury: loss of consciousness or altered consciousness; loss of memory for events before, during, or after the injury; or observed signs of neurological or neuropsychological dysfunction.[5]

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[3] Thurman D, Guerrero J. Trends in hospitalization associated with traumatic brain injury. JAMA 1999; 282(10):954-957.

[4] Annegers JF, Grabow JD, Kurland LT, Laws ER, Jr. The incidence, causes, and secular trends of head trauma in Olmsted County, Minnesota, 1935-1974. Neurology 1980;30(9):912-9.

Operational Definition: The MDH identified a population of patients who met the following criteria:
1) coded with one of the following ICD-9-CM N-codes, either as a **principal or secondary** diagnosis: [6]

800.00-800.99 - fracture of vault of skull
801.00-801.99 - fracture of base of skull
803.00-803.99 - other and unqualified skull fractures
804.00-804.99 - multiple fractures involving skull or face with other bones
850.0-850.9 - concussion
851.00-851.99 - cerebral laceration and contusion
852.00-852.59 - subarachnoid, subdural, and extradural hemorrhage, following injury
853.00-853.19 - other and unspecified intracranial hemorrhage following injury
854.00-854.19 - intracranial injury of other and unspecified nature
950.1-950.3 - injury to the optic chiasm, optic pathways and visual cortex
959.01 – head injury, unspecified
995.55 - shaken infant syndrome;

2) admitted as an inpatient to an acute care hospital;
3) nonfatal discharge from acute care;
4) resident of Minnesota; and
5) injury sustained between January 1, 1998 and December 31, 2003.

Excludes brain dysfunction caused by congenital or degenerative disorders, birth trauma, and brain injuries caused by anoxia due to trauma.[7]

Data Collection and Processing
Per CDC guidelines, basic (core) data are consistent with that of other TBI surveillance states: demographic features, ICD-9-CM diagnosis codes, ICD-9-CM procedure codes and external cause of injury (E codes).

Quality Assurance, Data Unduplication and Linkage
The MDH has an existing unduplication and sequencing program that sequences all MHA records for unique injury events and flags the final acute care treatment using gender, ZIP code, dates of birth, admission, discharge, and injury (where valued), discharge status, and source of admission. The TBI/SCI Registry also has an unduplication and sequencing program, incorporating name, dates of injury, admission, and discharge, hospital ID number, and medical record number.

Cases meeting the operational case definition were selected from both data systems (the Registry and MHA). The data sets were put through additional unduplication processes before linking them.

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[5] Coronado VG, Jones B (ed.): **Report to Congress on Mild Traumatic Brain Injury in the United States**. Atlanta, GA: Centers for Disease Control and Prevention, September 2003.

[6] Kinde M, Roesler J: Case Report Definition – Traumatic Brain Injury / Spinal Cord Injury Registry. St. Paul: Minnesota Department of Health, September 1, 2003.

[7] Section 1261(h)(4) of the U.S. Public Health Service Act (42 U.S.C. 300d-61(h)(4)), Definitions.

These include unduplication and data cleaning of case ID variables and the final acute care flag. Additionally, each data set was linked via the LinkPro SAS application with a copy of itself, requiring a match on all or most of the following variables: hospital ID number, medical record number, date of birth, gender, date of admission, and date of discharge. Duplicates were found among "ties," which happen when more than one case qualifies as a "match."

The data sets were then linked with LinkPro, requiring a match on at least five of the following variables: hospital ID number, medical record number, date of birth (including conditional matching on year or month/day of birth given non-matches on the exact date), gender, date of admission, and date of discharge. Both links and non-links were appended into the final data set.

Frequencies were calculated on key variables to ascertain completeness of the data. Errors were documented and corrected. A systematic review of data to assess for nonsense responses/outliers was performed.

Variables
Variables were valued first with Registry information and then, if missing, with MHA data values. Year and age group were based on the date of injury or, if missing, the date of admission. Causes were based on the first listed valid E-code.

Additional variables were abbreviated injury score (AIS) of the head, AVPU score (alert, verbal, pain response, unresponsive), blood alcohol concentration, cause, charges, county, discharge disposition, drug use, ethnicity, gender, GCS, GOS, injury severity score (ISS), intent, length of stay, MV traffic-related, non-traffic-related, race, TBI diagnosis code and zip.

Data Analysis
PC SAS statistical computing software version 9.1 (SAS Institute, Cary, NC)
Microsoft Excel 2000 (Microsoft Corporation, Redmond,WA)
Age-adjusted rates per 100,000 were calculated across various variables such as age, gender, area of residence, and cause.

Limitations
The data are incomplete for race, ethnicity, E-codes, and other factors. MHA data, for example, does not contain certain key variables such as race, ethnicity, Glasgow coma scale (GCS), Glasgow Outcome Scale (GOS), AVPU scale, blood alcohol, and drug use. Additionally, there is incomplete reporting of data by non-participating hospitals and by federal facilities such as VA medical centers and Indian Health Services facilities

Border leakage: There is some incompleteness of reporting from the western part of the state because of trauma treatment in North and South Dakota.

Results

Over the six-year period, there were 25,328 cases of nonfatal hospitalized TBI in Minnesota, or an annualized rate of 85.1 per 100,000 population (Table 1). The rates showed a strictly

increasing trend from 78.8 in 1998 to 91.3 in 2003. The rate of TBI was higher in the seven-county metropolitan area (89.0/100,000) than in greater Minnesota (82.4/100,000).

Figure 1 compares the first five years that MDH was able to analyze hospital data (1993-97) with the following six years (1998-2003), to determine an eleven-year trend. Several factors make comparison challenging. The increase in hospitalized TBI after 1997 is primarily due to the inclusion of MHA data, added to the MDH system beginning in data year 1998. The increase from 1998-2003 could be due in part to better reporting by hospitals to both MHA and the Registry as MDH expanded its efforts to work with medical records staff and hospital administration. Use of the 959.01 code would appear to inflate the data artificially, since MDH abstraction determined that approximately *51%* of cases coded 959.01 did not meet the clinical case record definition of TBI, i.e., they lacked clinical indicators of TBI such as decreased level of consciousness. It appears that use of the 854 code is declining while 959.01 increases; this may indicate that the latter code is being substituted for the former.

Figure 2 is a state map showing the incidence of nonfatal TBI by county, and Table 2 reports numbers, rates, and ranks by county. Seven counties had fewer than 20 nonfatal hospitalized TBI cases over the six-year period, so their rates were not calculated. Highest rates tend to be in the eastern part of the state: the five counties with highest rates are Mille Lacs, Wabasha, Dodge, Fillmore, and Pine. The five counties with the lowest rates are Clay, Polk, Becker, Cottonwood, and Nobles. All are in the western part of the state and are closer to hospitals in North and South Dakota that do not regularly report data to the MDH. Lower rates in the western counties can be attributed to the "border leakage" phenomenon.

Our analysis shows disparities in the incidence of TBI, based on people's gender, age, and racial/ethnic background. Because motor vehicle crashes and falls are most frequently associated with TBI, those causes are analyzed separately. The analysis also shows the correlation between alcohol use and TBI.

Gender and Age: Figure 3 shows that, at all ages, TBI-related hospital discharge rates were higher for males than females. This is particularly noticeable for 15-to-19 year olds and 20-to-24 year olds, where motor vehicle crashes are a factor. For both genders, however, rates were highest for people aged 75 and over.

When analyzed by age group, the data show a tri-modal curve, with increased rates in infancy, youth and young adults, and people 75 and older. For specific numbers and rates by age group and gender, refer to Table 3.

Race: Race data are limited in reports from hospitals. Based on available information, Figure 7 shows that Black and Native American incidence of TBI is greater than their population would indicate (6% vs. 4% and 3% vs. 1%, respectively). Incidence of TBI among Asians, however, is lower than the population would indicate (2% vs. 3%).

Causes: For all ages combined, motor-vehicle traffic-related incidents and falls were the leading causes of injury for TBI-related hospital discharges (see Figure 5).

Motor vehicle crashes. More than three-fourths of the motor-vehicle traffic-related TBI discharges were injuries to occupants, 9 percent were to pedestrians, 9 percent were to motorcyclists, and 3 percent were to pedal cyclists hit by motor vehicles (Figure 4). Males had higher rates than females (39.3/100,000 compared with 22.6/100,000), and the peak ages were 15-19 and 20-24 (Table 4).

Falls. Falls have a high peak for age under 1, then a gradual increase beginning at age 40 and a steep climb beginning at age 70. Males generally have higher rates of falls than females, 39.2/100,000 as compared with 24.0/100,000. Table 5 provides data on number and rates of TBI by age and gender, when the causes are falls, struck by or against (unintentional), assault, and pedal cyclist, nontraffic.

Length of hospital stay: Length of hospital stay, which likely correlates with severity of injury, varies by age group. As Figure 6 shows, stays are longer for the very young (under age 1, when 25 percent have stays of five days or more), but stays decrease in length from ages one to fourteen, then generally increase as the patient ages.

Use of personal protective equipment (PPE): An estimated 34% of motor vehicle occupants, 24% of motorcyclists, and 10% of pedal cyclists injured in motor vehicle collisions were reported to have been using PPE at the time of injury. Not using PPE were 24 percent of motor vehicle occupants, 34 percent of motorcyclists, and 38 percent of pedal cyclists. Use or nonuse was unknown for approximately 42% of occupants, 41% of motorcyclists, and 52% of pedal cyclists.

Alcohol use: As shown in Table 6, alcohol use was reported for motor vehicle crashes (occupants, motorcyclists, pedal cyclists) and all pedestrians. It also was reported for unintentional falls, unintentional "struck by or against" injuries, and assaults.

For motor vehicle crashes, blood alcohol level (BAC) less than 0.08 was reported for 4 percent of occupants, 7 percent of motorcyclists, and only 0.4 percent of pedal cyclists. Additionally, BAC less than 0.08 was reported for 5 percent of assaults and 1 percent of pedestrians.

At the BAC levels between 0.10 and 0.199, percentages were even higher. Heavy alcohol use (0.200 and greater) was reported among 16 percent of assaults, 10 percent of pedestrians, 8 percent of occupants, and 8 percent of motorcyclists. Alcohol use was unknown or not reported for 37 percent of occupants, 34 percent of motorcyclists, 46 percent of pedal cyclists, and 45 percent of pedestrians.

Discussion

These findings emphasize the importance of TBI as a public health problem. The results also indicate the need for TBI prevention programs and services for persons with TBI-related disability.

Table 1: Number and Rate of Nonfatal Hospitalized TBI by County and Year, Minnesota 1998-2003

	1998-2003		1998		1999		2000		2001		2002		2003	
County	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Minnesota	25328	85.1	3751	78.8	3893	80.8	4030	81.6	4358	86.9	4627	91.3	4669	91.2
7 County Metro	13602	89.4	2010	82.2	2162	87.6	2250	89.2	2285	89.2	2401	92.9	2494	95.4
Greater Minnesota	11689	82.0	1721	75.6	1727	75.4	1777	74.9	2071	85.8	2224	91.4	2169	88.6
Aitkin	85	77.2	12	.	15	.	13	.	14	.	16	.	15	.
Anoka	1413	88.3	197	75.1	206	77.1	226	92.0	272	103.4	251	90.2	261	92.3
Becker	48	25.2	11	.	7	.	6	.	5	.	13	.	6	.
Beltrami	134	56.6	13	.	30	80.4	18	.	27	68.6	22	52.3	24	59.9
Benton	263	123.7	47	135.7	26	71.4	54	158.3	53	153.4	37	96.9	46	126.6
Big Stone	24	56.4	5	.	4	.	1	.	5	.	3	.	6	.
Blue Earth	231	66.6	37	66.4	30	54.6	48	82.5	39	70.0	33	54.9	44	71.4
Brown	119	68.0	16	.	21	75.3	19	.	16	.	21	74.4	26	83.6
Carlton	204	101.7	37	117.3	27	84.1	30	89.8	34	101.7	38	108.6	38	109.0
Carver	272	70.8	26	44.4	46	72.9	54	90.7	49	80.1	36	50.0	61	86.5
Cass	155	94.9	28	104.0	20	85.6	18	.	24	86.1	33	116.7	32	115.6
Chippewa	54	63.2	6	.	13	.	6	.	9	.	9	.	11	.
Chisago	251	99.0	39	100.4	31	70.3	37	96.7	37	86.1	49	113.2	58	127.1
Clay	25	8.0	4	.	7	.	2	.	6	.	2	.	4	.
Clearwater	27	52.8	6	.	4	.	2	.	2	.	7	.	6	.
Cook	30	92.6	5	.	4	.	3	.	2	.	4	.	12	.
Cottonwood	28	30.7	5	.	0	.	6	.	8	.	4	.	5	.
Crow Wing	316	90.8	48	91.5	41	71.4	58	100.0	65	111.5	59	97.7	45	72.3
Dakota	1462	76.5	219	74.4	222	71.4	231	71.0	235	72.5	280	85.0	275	84.5
Dodge	169	156.9	25	146.6	28	166.2	37	207.3	32	175.3	25	127.3	22	118.6
Douglas	159	75.6	33	92.7	18	.	27	81.9	24	68.0	27	72.9	30	80.1
Faribault	108	107.0	13	.	8	.	16	.	30	176.6	21	123.4	20	121.8
Fillmore	179	142.3	24	113.9	37	196.1	34	149.4	31	151.7	31	143.3	22	99.3
Freeborn	142	70.9	20	59.9	19	.	23	67.4	24	68.1	32	98.2	24	70.0
Goodhue	330	126.2	45	109.0	52	122.4	49	110.0	62	143.3	66	148.8	56	123.8
Grant	34	81.0	0	.	8	.	5	.	5	.	11	.	5	.
Hennepin	6125	93.8	936	89.0	1035	97.9	1025	93.5	1035	93.4	1030	93.2	1064	96.0
Houston	44	36.2	0	.	12	.	8	.	9	.	8	.	7	.
Hubbard	47	41.8	11	.	4	.	3	.	6	.	9	.	14	.
Isanti	189	98.5	30	110.5	29	98.1	30	93.5	24	74.0	37	111.1	39	104.0
Itasca	257	96.6	41	95.1	38	94.9	33	70.0	56	120.5	39	85.7	50	113.2
Jackson	23	30.5	6	.	3	.	2	.	5	.	4	.	3	.
Kanabec	98	110.8	8	.	13	.	16	.	23	162.4	21	144.6	17	.
Kandiyohi	165	65.1	21	50.4	37	88.0	22	52.7	27	61.9	28	65.5	30	72.0
Kittson	6	.	2	.	0	.	0	.	0	.	3	.	1	.
Koochiching	61	72.3	11	.	11	.	7	.	9	.	12	.	11	.
Lac Qui Parle	55	96.5	11	.	7	.	8	.	10	.	7	.	12	.
Lake	60	97.1	5	.	17	.	8	.	12	.	7	.	11	.
Lake Of The Woods	19	.	1	.	4	.	3	.	2	.	4	.	5	.
Le Sueur	178	112.2	16	.	26	102.4	43	168.0	28	100.5	33	122.6	32	116.0
Lincoln	24	45.1	6	.	1	.	5	.	5	.	3	.	4	.
Lyon	97	58.9	10	.	14	.	17	.	17	.	17	.	22	86.5
Mahnomen	13	.	2	.	1	.	2	.	5	.	0	.	3	.
Marshall	13	.	0	.	3	.	1	.	1	.	7	.	1	.
Martin	119	91.3	20	92.4	18	.	18	.	19	.	20	92.3	24	101.2
Mcleod	160	73.7	27	76.4	26	74.6	19	.	27	74.1	22	59.9	39	101.1
Meeker	103	73.3	17	.	17	.	15	.	18	.	20	84.1	16	.
Mille Lacs	223	164.2	34	150.0	26	129.3	33	154.1	36	161.3	46	189.7	48	201.0
Morrison	194	100.5	20	71.9	29	92.3	37	116.6	33	100.9	33	100.3	42	121.0
Mower	232	90.8	35	83.7	30	75.0	40	96.1	37	91.5	47	106.4	43	92.2
Murray	31	57.2	13	.	3	.	0	.	7	.	4	.	4	.
Nicollet	91	49.8	10	.	12	.	13	.	18	.	22	68.8	16	.
Nobles	40	31.9	3	.	8	.	10	.	6	.	6	.	7	.
Norman	18	.	2	.	2	.	3	.	6	.	2	.	3	.
Olmsted	839	113.7	138	119.0	115	96.9	132	109.0	143	116.4	195	152.5	116	88.3
Otter Tail	151	39.7	10	.	21	38.2	12	.	29	46.1	35	50.2	44	66.5
Pennington	22	25.2	3	.	5	.	4	.	3	.	6	.	1	.
Pine	196	122.5	22	89.3	24	94.6	39	150.1	33	122.4	47	172.2	31	106.3
Pipestone	32	41.4	8	.	3	.	5	.	1	.	5	.	10	.
Polk	53	25.1	9	.	5	.	10	.	7	.	14	.	8	.
Pope	48	64.1	1	.	17	.	9	.	5	.	6	.	10	.
Ramsey	3039	99.1	462	93.4	459	91.2	504	97.7	478	92.5	555	107.1	581	112.9
Red Lake	9	.	3	.	1	.	1	.	0	.	3	.	1	.
Redwood	82	81.6	10	.	14	.	11	.	13	.	11	.	23	151.5
Renville	102	94.3	15	.	27	160.6	17	.	14	.	12	.	17	.
Rice	264	74.8	26	46.1	45	82.4	45	78.1	53	91.1	49	78.0	46	72.9
Rock	15	.	2	.	0	.	1	.	5	.	3	.	4	.
Roseau	35	36.2	6	.	8	.	4	.	3	.	13	.	1	.
St. Louis	1266	100.9	189	92.8	181	91.6	161	74.9	246	116.5	239	109.8	250	119.7
Scott	406	81.6	56	80.0	54	66.9	71	87.5	79	93.2	71	82.7	75	79.1
Sherburne	338	86.2	37	63.1	49	81.7	39	60.1	61	90.4	68	103.6	84	118.1
Sibley	77	78.9	4	.	13	.	12	.	24	140.0	13	.	11	.
Stearns	757	95.0	127	99.0	112	85.0	99	75.1	136	103.5	131	96.5	152	111.0
Steele	173	84.3	26	85.0	19	.	23	65.5	26	71.9	46	129.8	33	93.9
Stevens	55	70.6	8	.	6	.	7	.	10	.	12	.	12	.
Swift	72	96.4	6	.	14	.	9	.	13	.	16	.	14	.
Todd	140	96.3	20	96.4	26	110.5	23	95.1	26	97.3	22	88.0	23	90.7
Traverse	19	.	1	.	2	.	2	.	6	.	7	.	1	.
Wabasha	188	148.1	33	160.7	29	138.0	36	179.8	29	128.5	38	174.5	23	107.0
Wadena	65	77.4	12	.	7	.	9	.	9	.	17	.	11	.
Waseca	142	123.5	33	188.3	20	112.3	25	120.1	25	125.9	18	.	21	106.5
Washington	885	82.0	114	65.8	140	79.5	139	78.8	137	78.6	178	97.6	177	91.7
Watonwan	50	70.7	11	.	10	.	6	.	5	.	13	.	5	.
Wilkin	19	.	4	.	1	.	4	.	3	.	6	.	1	.
Winona	237	76.4	37	72.2	41	78.1	28	53.0	47	93.8	42	83.9	42	77.5
Wright	507	96.4	72	88.2	69	86.2	85	102.4	79	92.4	104	107.9	98	101.3
Yellow Medicine	61	77.6	7	.	2	.	11	.	17	.	9	.	15	.
County Unknown	37	.	20	.	4	.	3	.	2	.	2	.	6	.

Rates are age-adjusted to the U.S. 2000 standard population. Unstable rates (for less than 20 cases) are not displayed. The 1998-2003 rate is annualized

Figure 1

Nonfatal Hospitalized TBI Rate by Year

Minnesota 1993-2003

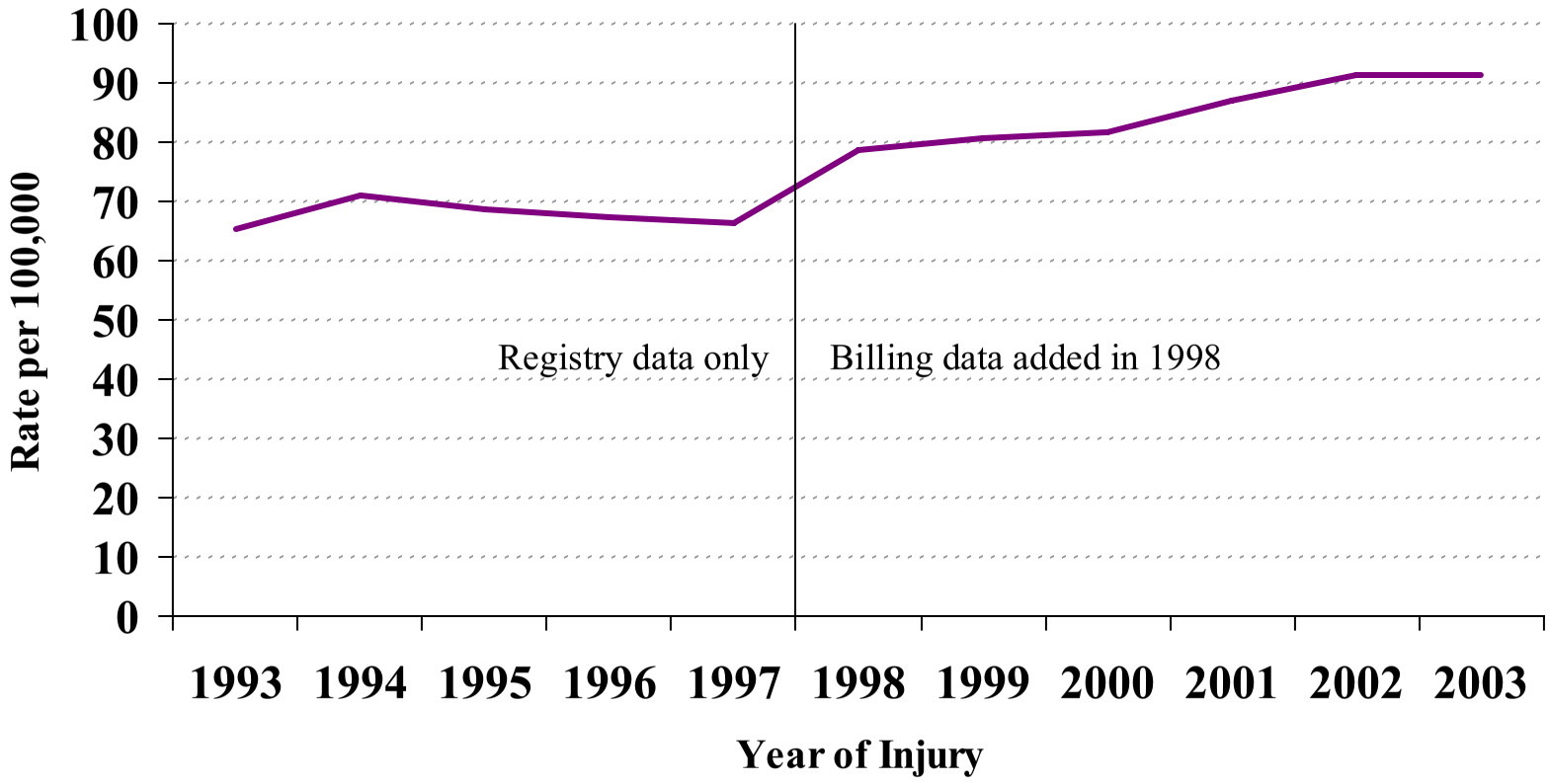


Table 2: Ranking of Nonfatal Hospitalized TBI County Rates, Minnesota 1998-2003

	1998-2003		
		Annualized	
County	**N**	**Rate**	**Rank**
Mille Lacs	223	164.2	1
Dodge	169	156.9	2
Wabasha	188	148.1	3
Fillmore	179	142.3	4
Goodhue	330	126.2	5
Benton	263	123.7	6
Waseca	142	123.5	7
Pine	196	122.5	8
Olmsted	839	113.7	9
Le Sueur	178	112.2	10
Kanabec	98	110.8	11
Faribault	108	107.0	12
Carlton	204	101.7	13
St. Louis	1266	100.9	14
Morrison	194	100.5	15
Ramsey	3039	99.1	16
Chisago	251	99.0	17
Isanti	189	98.5	18
Lake	60	97.1	19
Itasca	257	96.6	20
Lac Qui Parle	55	96.5	21
Wright	507	96.4	22
Swift	72	96.4	22
Todd	140	96.3	23
Stearns	757	95.0	24
Cass	155	94.9	25
Renville	102	94.3	26
Hennepin	6125	93.8	27
Cook	30	92.6	28
Martin	119	91.3	29
Mower	232	90.8	30
Crow Wing	316	90.8	31
7 County Metro	**13602**	**89.4**	
Anoka	1413	88.3	32
Sherburne	338	86.2	33
Minnesota	**25328**	**85.1**	
Steele	173	84.3	34
Washington	885	82.0	35
Greater Minnesota	**11689**	**82.0**	
Redwood	82	81.6	36
Scott	406	81.6	37
Grant	34	81.0	38
Sibley	77	78.9	39
Yellow Medicine	61	77.6	40
Wadena	65	77.4	41
Aitkin	85	77.2	42
Dakota	1462	76.5	43
Winona	237	76.4	44
Douglas	159	75.6	45
Rice	264	74.8	46
Mcleod	160	73.7	47
Meeker	103	73.3	48
Koochiching	61	72.3	49
Freeborn	142	70.9	50
Carver	272	70.8	51
Watonwan	50	70.7	52
Stevens	55	70.6	53
Brown	119	68.0	54
Blue Earth	231	66.6	55
Kandiyohi	165	65.1	56
Pope	48	64.1	57
Chippewa	54	63.2	58
Lyon	97	58.9	59
Murray	31	57.2	60
Beltrami	134	56.6	61
Big Stone	24	56.4	62
Clearwater	27	52.8	63
Nicollet	91	49.8	64
Lincoln	24	45.1	65
Hubbard	47	41.8	66
Pipestone	32	41.4	67
Otter Tail	151	39.7	68
Roseau	35	36.2	69
Houston	44	36.2	69
Nobles	40	31.9	70
Cottonwood	28	30.7	71
Jackson	23	30.5	72
Pennington	22	25.2	73
Becker	48	25.2	73
Polk	53	25.1	74
Clay	25	8.0	75

Rates are age-adjusted to the U.S. 2000 population.

Exclusions: Cases with unknown county and counties with unstable rates (N<20 cases): Kittson, Lake of the Woods, Mahnonen, Marshall, Norman, Red Lake, Rock, Traverse and Wilkin.

Figure 2

Nonfatal Hospitalized TBI Rate by County

Minnesota 1998-2003

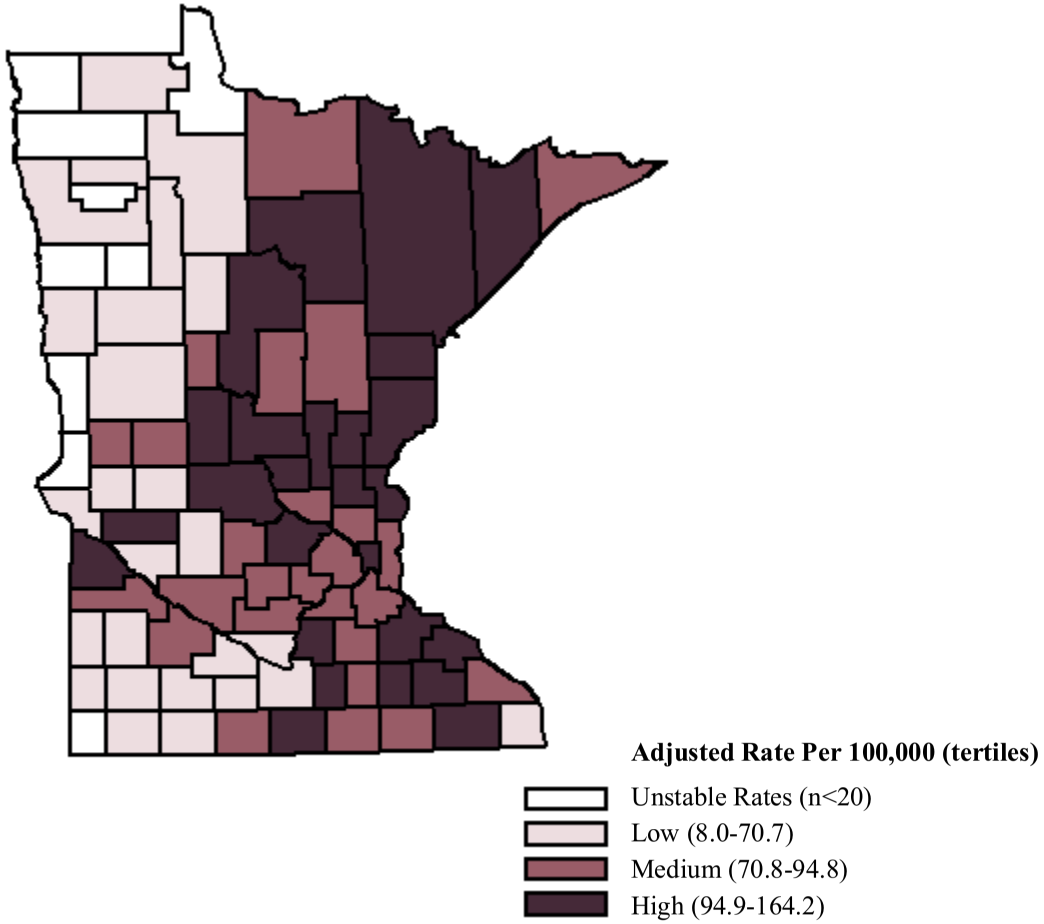


Table 3: Number and Rate of Nonfatal Hospitalized TBI by Age Group and Gender, Minnesota 1998-2003

	Total		Male		Female	
Age Group	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
All Ages	**25328**	**85.4**	**16084**	**113.4**	**9244**	**58.2**
<1	539	133.2	310	149.7	229	115.9
1-4	768	48.8	448	55.6	320	41.7
5-9	951	44.5	647	59.0	304	29.3
10-14	1320	58.7	932	80.9	388	35.4
15-19	2830	126.0	1895	164.9	935	85.2
20-24	2217	114.6	1692	171.9	525	55.2
25-29	1522	79.3	1141	117.3	381	40.3
30-34	1371	64.7	952	88.9	419	39.9
35-39	1622	65.5	1153	92.4	469	38.2
40-44	1635	66.2	1126	90.5	509	41.5
45-49	1399	64.0	981	89.0	418	38.6
50-54	1118	61.8	756	83.6	362	40.0
55-59	912	67.0	606	90.0	306	44.5
60-64	759	71.1	493	94.8	266	48.5
65-69	792	86.2	480	110.0	312	64.6
70-74	1026	119.9	591	152.4	435	92.9
75-79	1253	170.2	652	210.2	601	141.1
80-84	1419	262.3	580	288.8	839	246.7
85+	1874	364.9	649	445.0	1225	333.1

Total rates are annualized and adjusted to the U.S. 2000 standard population.

One case with unknown age is included in total counts only.

Figure 3

Nonfatal Hospitalized TBI Rate by Age Group and Gender

Minnesota 1998-2003

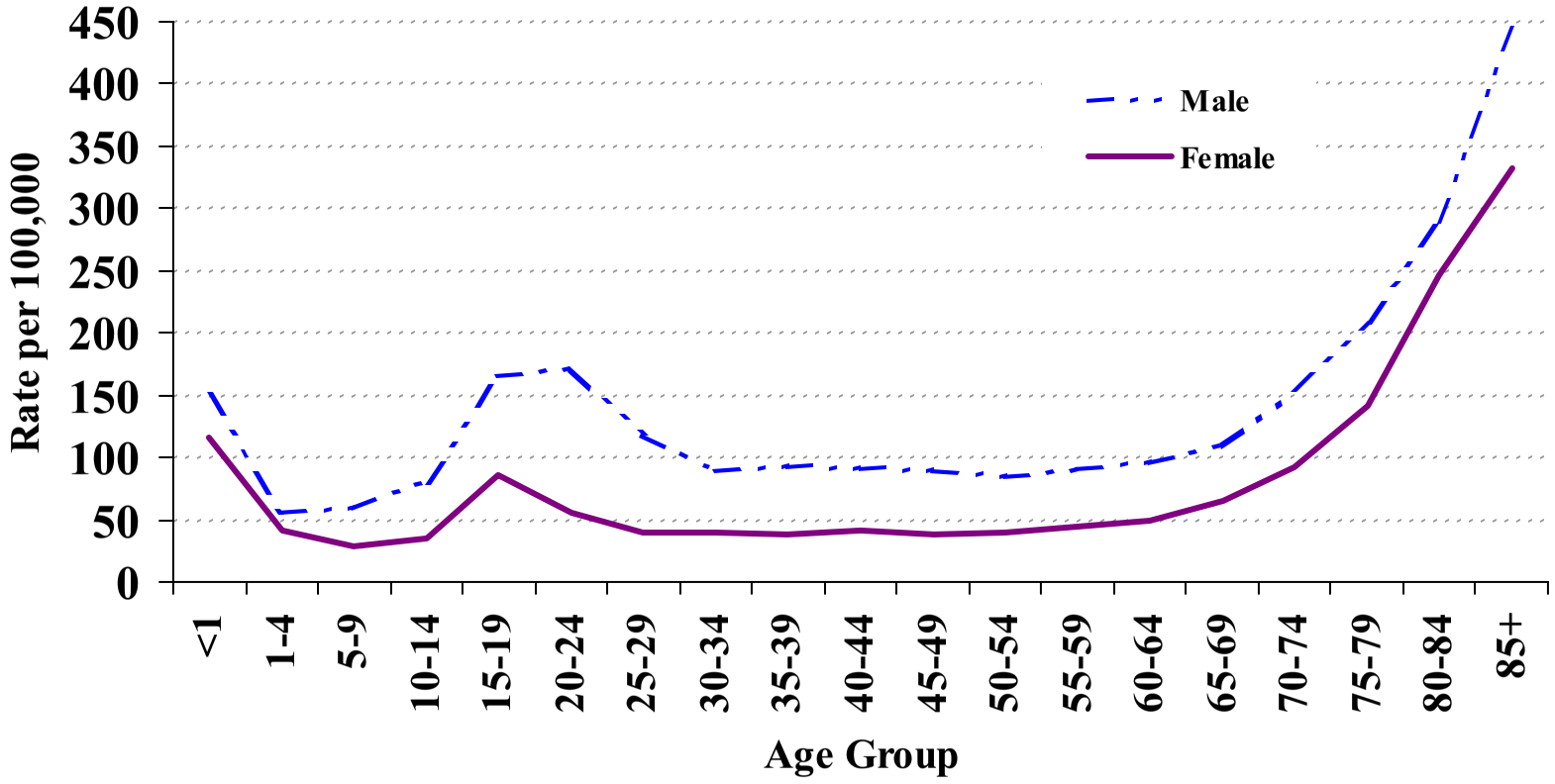


Table 4: Number and Rate of Motor Vehicle Traffic-Related Nonfatal Hospitalized TBI by Gender, Age Group, and Cause, Minnesota 1998-2003

	Motor vehicle traffic, total		Motor vehicle traffic, occupant		Motor vehicle traffic, motorcyclist		Motor vehicle traffic, pedal cyclist		Motor vehicle traffic, pedestrian	
Total	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
All Ages	9186	30.9	7032	23.6	869	2.9	277	0.9	837	2.8
<1	30	7.4	30	7.4	0	.	0	.	0	.
1-4	154	9.8	95	6.0	0	.	5	.	54	3.4
5-9	317	14.9	145	6.8	5	.	56	2.6	109	5.1
10-14	427	19.0	213	9.5	18	.	82	3.6	101	4.5
15-19	1725	76.8	1516	67.5	55	2.5	34	1.5	77	3.4
20-24	1304	67.4	1081	55.9	128	6.6	10	.	55	2.8
25-29	843	43.9	671	35.0	103	5.4	5	.	42	2.2
30-34	665	31.4	511	24.1	87	4.1	12	.	45	2.1
35-39	720	29.1	533	21.5	110	4.4	9	.	55	2.2
40-44	673	27.3	469	19.0	128	5.2	14	.	52	2.1
45-49	527	24.1	368	16.8	97	4.4	18	.	37	1.7
50-54	389	21.5	260	14.4	73	4.0	9	.	44	2.4
55-59	310	22.8	228	16.8	39	2.9	4	.	34	2.5
60-64	194	18.2	147	13.8	14	.	6	.	26	2.4
65-69	188	20.5	155	16.9	5	.	5	.	20	2.2
70-74	201	23.5	162	18.9	5	.	6	.	23	2.7
75-79	213	28.9	187	25.4	2	.	0	.	23	3.1
80-84	187	34.6	159	29.4	0	.	0	.	27	5.0
85+	118	23.0	101	19.7	0	.	2	.	13	.
Male	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
All Ages	5801	39.3	4221	28.6	729	4.9	215	1.4	509	3.5
<1	14	.	14	.	0	.	0	.	0	.
1-4	92	11.4	48	6.0	0	.	4	.	40	5.0
5-9	204	18.6	82	7.5	4	.	40	3.6	76	6.9
10-14	270	23.4	124	10.8	17	.	64	5.6	55	4.8
15-19	1040	90.5	891	77.5	44	3.8	29	2.5	41	3.6
20-24	923	93.8	750	76.2	115	11.7	7	.	30	3.1
25-29	588	60.4	446	45.9	92	9.5	5	.	29	3.0
30-34	419	39.1	299	27.9	68	6.4	10	.	34	3.2
35-39	469	37.6	329	26.4	88	7.1	7	.	36	2.9
40-44	434	34.9	275	22.1	103	8.3	12	.	37	3.0
45-49	334	30.3	214	19.4	75	6.8	16	.	25	2.3
50-54	245	27.1	146	16.1	65	7.2	5	.	26	2.9
55-59	187	27.8	131	19.5	34	5.1	2	.	18	.
60-64	117	22.5	83	16.0	13	.	4	.	16	.
65-69	97	22.2	79	18.1	4	.	4	.	8	.
70-74	104	26.8	81	20.9	5	.	4	.	10	.
75-79	119	38.4	103	33.2	2	.	0	.	13	.
80-84	93	46.3	81	40.3	0	.	0	.	12	.
85+	52	35.7	45	30.9	0	.	2	.	3	.
Female	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
All Ages	3385	22.6	2811	18.7	140	0.9	62	0.4	328	2.2
<1	16	.	16	.	0	.	0	.	0	.
1-4	62	8.1	47	6.1	0	.	1	.	14	.
5-9	113	10.9	63	6.1	1	.	16	.	33	3.2
10-14	157	14.3	89	8.1	1	.	18	.	46	4.2
15-19	685	62.4	625	57.0	11	.	5	.	36	3.3
20-24	381	40.1	331	34.8	13	.	3	.	25	2.6
25-29	255	27.0	225	23.8	11	.	0	.	13	.
30-34	246	23.5	212	20.2	19	.	2	.	11	.
35-39	251	20.5	204	16.6	22	1.8	2	.	19	.
40-44	239	19.5	194	15.8	25	2.0	2	.	15	.
45-49	193	17.8	154	14.2	22	2.0	2	.	12	.
50-54	144	15.9	114	12.6	8	.	4	.	18	.
55-59	123	17.9	97	14.1	5	.	2	.	16	.
60-64	77	14.1	64	11.7	1	.	2	.	10	.
65-69	91	18.9	76	15.7	1	.	1	.	12	.
70-74	97	20.7	81	17.3	0	.	2	.	13	.
75-79	94	22.1	84	19.7	0	.	0	.	10	.
80-84	94	27.6	78	22.9	0	.	0	.	15	.
85+	66	18.0	56	15.2	0	.	0	.	10	.

Rates are annualized and per 100,000 population. Total rates are adjusted to the U.S. 2000 standard population.

Total motor vehicle traffic contains other and unspecified motor vehicle traffic causes.

Figure 4

Motor Vehicle Traffic-Related Nonfatal Hospitalized TBI by Cause

Minnesota 1998-2003

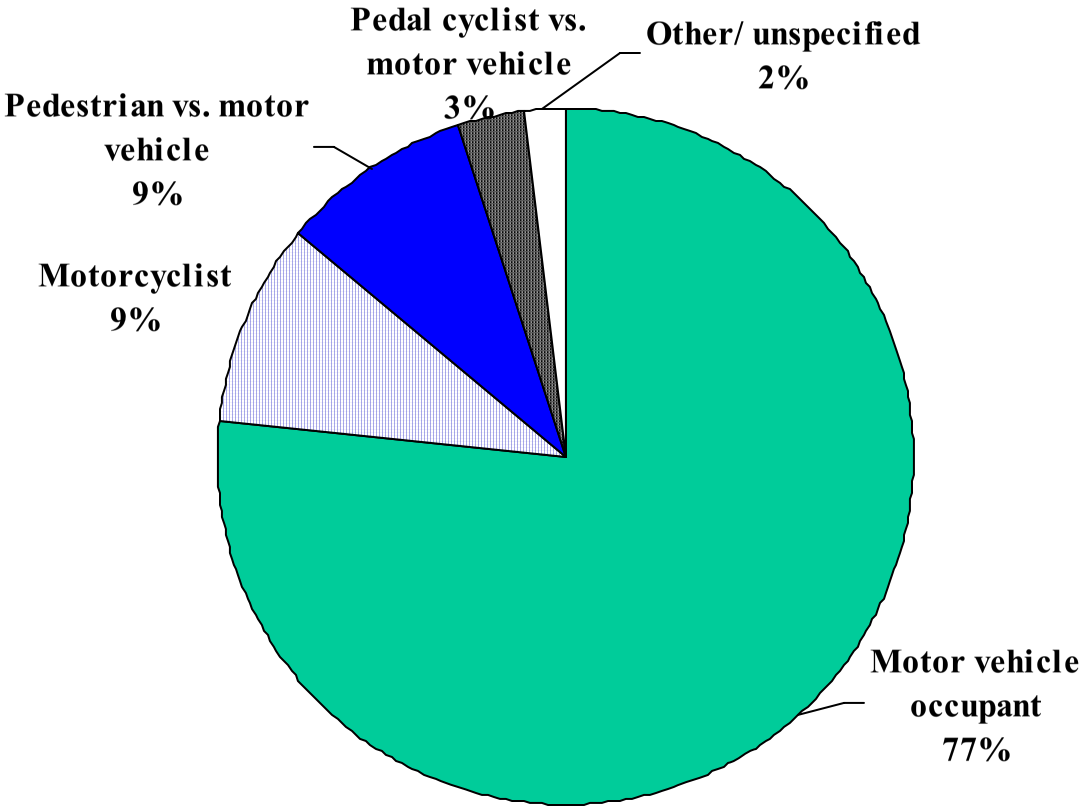


Table 5: Number and Rate of Nonfatal Hospitalized TBI by Gender, Age Group, and Selected Non-Motor Vehicle Causes
Minnesota 1998-2003

		Fall, unintentional		All Assault		Struck by/ against, unintentional		Pedal cyclist, nontraffic	
Total		**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
	All Ages	9211	31.2	1871	6.3	1064	3.6	695	2.3
	<1	319	78.8	93	23.0	27	6.7	0	.
	1-4	407	25.9	21	1.3	77	4.9	17	.
	5-9	286	13.4	6	.	123	5.8	82	3.8
	10-14	270	12.0	47	2.1	156	6.9	189	8.4
	15-19	309	13.8	228	10.2	162	7.2	66	2.9
	20-24	229	11.8	304	15.7	81	4.2	24	1.2
	25-29	201	10.5	211	11.0	47	2.5	29	1.5
	30-34	220	10.4	189	8.9	51	2.4	29	1.4
	35-39	332	13.4	248	10.0	49	2.0	39	1.6
	40-44	390	15.8	206	8.3	60	2.4	40	1.6
	45-49	426	19.5	143	6.5	47	2.2	50	2.3
	50-54	411	22.7	92	5.1	33	1.8	40	2.2
	55-59	389	28.6	31	2.3	24	1.8	40	2.9
	60-64	406	38.0	23	2.2	20	1.9	17	.
	65-69	443	48.2	9	.	25	2.7	14	.
	70-74	673	78.6	4	.	23	2.7	11	.
	75-79	879	119.4	8	.	24	3.3	3	.
	80-84	1074	198.5	4	.	17	.	3	.
	85+	1547	301.2	4	.	18	.	2	.
Male		**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
	All Ages	5138	39.2	1568	10.4	779	5.2	533	3.5
	<1	177	85.5	63	30.4	13	.	0	.
	1-4	224	27.8	9	.	51	6.3	9	.
	5-9	200	18.2	6	.	94	8.6	60	5.5
	10-14	201	17.4	39	3.4	116	10.1	146	12.7
	15-19	221	19.2	206	17.9	118	10.3	59	5.1
	20-24	189	19.2	275	27.9	69	7.0	19	.
	25-29	163	16.8	179	18.4	43	4.4	22	2.3
	30-34	150	14.0	157	14.7	40	3.7	25	2.3
	35-39	243	19.5	207	16.6	36	2.9	33	2.6
	40-44	270	21.7	168	13.5	48	3.9	24	1.9
	45-49	299	27.1	123	11.2	40	3.6	36	3.3
	50-54	286	31.6	75	8.3	20	2.2	29	3.2
	55-59	260	38.6	26	3.9	17	.	36	5.4
	60-64	254	48.9	19	.	15	.	12	.
	65-69	268	61.4	8	.	19	.	7	.
	70-74	379	97.7	2	.	16	.	9	.
	75-79	433	139.6	4	.	16	.	2	.
	80-84	411	204.6	1	.	3	.	3	.
	85+	510	349.7	1	.	5	.	2	.
Female		**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
	All Ages	4073	24.0	303	2.0	285	1.9	162	1.1
	<1	142	71.9	30	15.2	14	.	0	.
	1-4	183	23.9	12	.	26	3.4	8	.
	5-9	86	8.3	0	.	29	2.8	22	2.1
	10-14	69	6.3	8	.	40	3.7	43	3.9
	15-19	88	8.0	22	2.0	44	4.0	7	.
	20-24	40	4.2	29	3.1	12	.	5	.
	25-29	38	4.0	32	3.4	4	.	7	.
	30-34	70	6.7	32	3.1	11	.	4	.
	35-39	89	7.3	41	3.3	13	.	6	.
	40-44	120	9.8	38	3.1	12	.	16	.
	45-49	127	11.7	20	1.9	7	.	14	.
	50-54	125	13.8	17	.	13	.	11	.
	55-59	129	18.8	5	.	7	.	4	.
	60-64	152	27.7	4	.	5	.	5	.
	65-69	175	36.3	1	.	6	.	7	.
	70-74	294	62.8	2	.	7	.	2	.
	75-79	446	104.7	4	.	8	.	1	.
	80-84	663	194.9	3	.	14	.	0	.
	85+	1037	282.0	3	.	13	.	0	.

Rates are annualized and per 100,000 population. Total rates are adjusted to the U.S. 2000 standard population.

Figure 5

Leading Causes of Nonfatal Hospitalized TBI by Age Group

Minnesota, 1998-2003

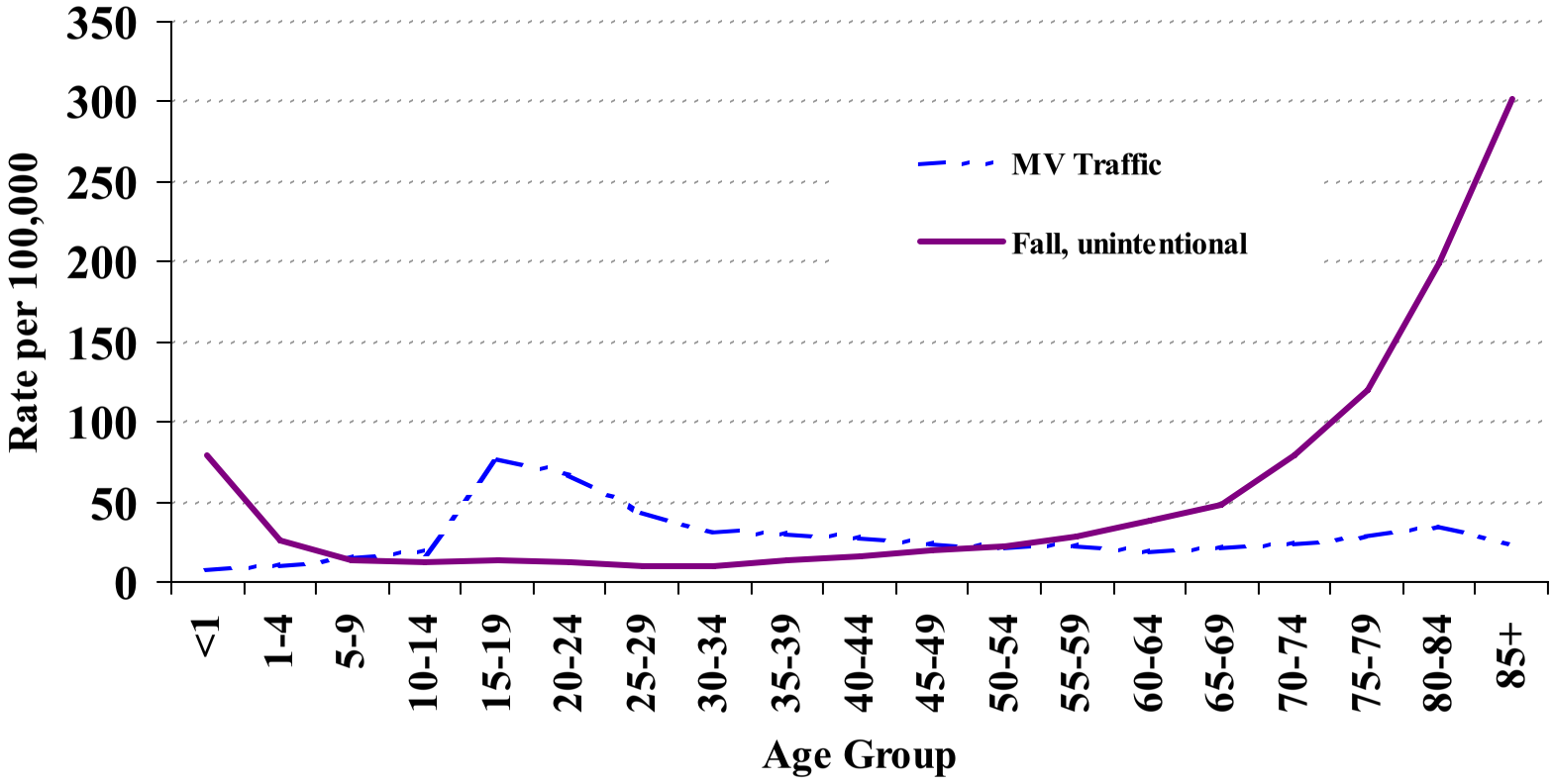


Table 6: Leading Causes by Race and Ethnicity for Nonfatal Hospitalized TBI, Minnesota 1998-1999

Cause		American Indian/ Alaskan Native	Asian/ Pacific Islander	Black	White	Other/ Unknown	Total	Hispanic	Not Hispanic/ Unknown	Total
Fall, unintentional	N	30	30	40	1428	584	2112	17	2095	2112
	Rate	47.4	9.0	19.6	15.1		21.3	20.9	21.5	21.3
MV traffic, occupant, unintentional	N	29	37	57	1054	617	1793	27	1767	1793
	Rate	23.8	10.4	14.7	11.6		18.0	9.7	18.3	18.0
Struck by/ against, unintentional	N	3	0	10	166	110	289	3	286	289
	Rate	2.1	0.0	1.8	1.9		2.9	0.6	3.0	2.9
Struck by/ against, assault	N	10	7	74	130	100	319	17	303	319
	Rate	6.9	1.8	16.6	1.4		3.2	4.9	3.1	3.2
All Other Causes	N	40	17	77	865	399	1397	23	1374	1397
	Rate	29.1	3.6	22.9	9.5		14.0	7.3	14.3	14.0
All Causes Total	N	112	90	257	3643	1809	5911	87	5824	5911
	Rate	109.3	24.8	75.7	39.6		59.4	43.5	60.2	59.4

Race data are from abstraction of medical records for two annual stratified random samples.

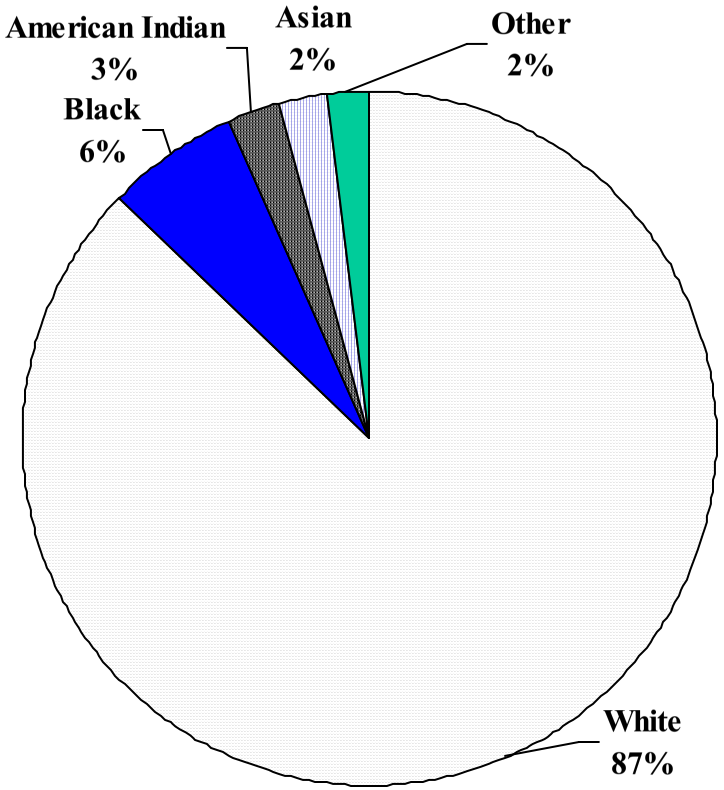
Numbers are weighted to reflect the size of the sampling pools.

Rates per 100,000 are annualized and adjusted to the U.S. 2000 standard population.

Figure 6

Nonfatal Hospitalized TBI by Race

Minnesota 1998-1999



N=1,258: abstracted sample cases with known race (73% of total sample).

Table 7: Personal Protective Equipment (PPE) and Alcohol Use by Selected Causes, Nonfatal Hospitalized TBI, MN 1998-2003

PPE Use	MV traffic, occupant	MV traffic, motorcyclist	MV traffic, pedal cyclist	Pedestrian	Fall, unintentional	Struck by/ against, unintentional	All Assault
Yes	34.1%	24.4%	9.4%				
No	23.9%	34.3%	38.3%				
NA/Unknown	42.0%	41.3%	52.4%				
BAC (g/dL)							
<0.010	0.6%	0.7%	0.0%	0.1%	0.2%	0.3%	0.5%
0.010-0.079	3.3%	5.9%	0.4%	1.1%	1.0%	0.5%	4.0%
0.080-0.099	1.0%	1.6%	0.4%	0.1%	0.2%	0.0%	1.6%
0.100-0.199	8.4%	9.8%	1.4%	3.6%	1.9%	0.8%	10.7%
>=0.200	8.4%	7.5%	2.9%	9.7%	4.7%	1.7%	16.3%
BAC not tested, clinical evidence of alcohol used	1.2%	1.8%	0.4%	1.1%	1.4%	0.3%	7.6%
No alcohol used	40.1%	39.2%	49.1%	39.3%	31.9%	39.2%	23.3%
Unknown/Not available	37.0%	33.5%	45.5%	45.0%	58.8%	57.3%	36.0%

Figure 7

Length of Hospital Stay for Nonfatal TBI by Age Group

Minnesota 1998-2003

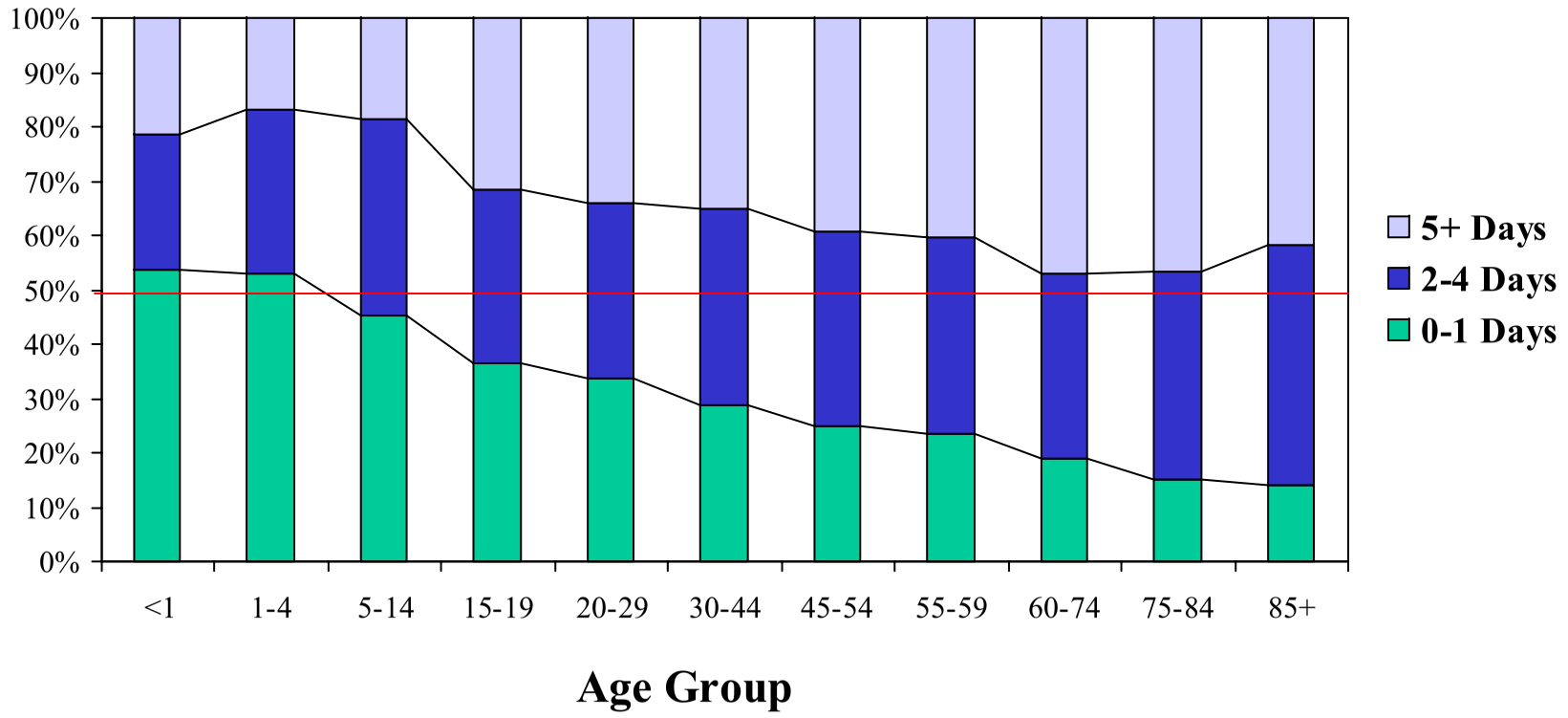


Table 8: Severity and Early Outcome Indicators by Age Group for Nonfatal Hospitalized TBI, Minnesota 1998-2003

		Age Group											
Length of Stay	**All Ages**	**<1**	**1-4**	**5-14**	**15-19**	**20-29**	**30-44**	**45-54**	**55-59**	**60-74**	**75-84**	**85+**
0-1 Days	29%	54%	53%	45%	36%	34%	29%	25%	24%	19%	15%	14%
2-4 Days	35%	25%	30%	36%	32%	32%	36%	36%	36%	34%	38%	44%
5+ Days	36%	21%	17%	19%	32%	34%	35%	39%	40%	47%	47%	42%
Discharge Status	**All Ages**	**<1**	**1-4**	**5-14**	**15-19**	**20-29**	**30-44**	**45-54**	**55-59**	**60-74**	**75-84**	**85+**
Transfer to Acute Care Hospital	2%	1%	1%	1%	1%	2%	2%	2%	3%	3%	2%	2%
Home - Self Care	65%	77%	78%	84%	78%	76%	73%	67%	67%	53%	36%	23%
Home - Nonskilled Assistance	4%	14%	12%	7%	3%	3%	3%	3%	3%	3%	2%	2%
Home - Skilled Assistance	4%	5%	4%	3%	2%	1%	2%	2%	3%	6%	10%	11%
Inpatient Rehab Facility	11%	0%	3%	4%	12%	12%	13%	15%	12%	14%	10%	4%
Transitional Care Unit	1%	0%	0%	0%	0%	1%	1%	1%	1%	2%	4%	5%
Residential Facility Without Skilled Nursing	3%	0%	0%	0%	0%	0%	0%	1%	2%	5%	11%	18%
Residential Facility With Skilled Nursing	6%	1%	0%	0%	0%	1%	2%	3%	5%	11%	20%	30%
Eloped / AMA	1%	0%	0%	0%	1%	1%	2%	2%	1%	1%	1%	0%
Other	3%	1%	1%	1%	2%	3%	3%	3%	3%	3%	4%	4%

Home includes foster home.

N=25,328

Figure 8

Discharge Status
Nonfatal Hospitalized TBI

Minnesota 1998-2003